

REMARKS

The Examiner's objections to the claims have been thoroughly considered, and the following comments are offered in response. The explanations and arguments responding to the Examiner's points are numbered using the same numbering of objections and rejections used by the Examiner in the Office Action for easy reference.

Amendments to the Claims

The claims have been amended to remove parenthetical expressions or abbreviations that the Office objected to. Those that were redundant and were only used to ensure accuracy and simplify interpretation have been removed. Those that merely abbreviated terms clearly set forth in the specification and other claims, such as EIPC for "electronically-insulating proton-conducting" and ASR for "area-specific resistance," have been replaced by the appropriate full expression. These amendments thus add no new matter.

Two of the coating materials listed in claims 78 and 87 were not fully set forth in the specification, and were thus deemed indefinite by the Office. Those materials have thus been deleted from the claims.

In claims 82 and 91, the Office objected to the use of the trademark name Nafion® 117 to identify a material whose properties were the basis for a claim limitation. The claims are amended to remove the functionally defined limitation, which has been replaced by a quantitative expression that is presented in the specification as equivalent to the limitation that was removed (see pg 45, ll. 15-17). This amendment thus does not change the scope of the claims or add new matter.

The Office objected to incorporation by reference of Figure 1 in claim 84. The applicants believe the claim limitation it communicates is best and most succinctly conveyed by the figure,

thus the figure has been added to the claim. Since Figure 1 was part of the original specification, it adds no new matter.

The Present Claims

1. Applicants acknowledge entry of claims 75 to 92 according to the 26 July 2004 amendment. Claims 75-82 and 84-91 are pending and stand rejected.
2. Applicants acknowledge the Office's withdrawal of claims 83 and 92, and note that their rejoinder should be permitted once a product claim is found allowable. See MPEP 821.04.

Objections

3. The Office objects to claims 75-77, 80-81, 84-86, and 89-90 under 35 U.S.C. § 132, alleging that they add new matter and specifically referring to the claim amendment which includes the phrase "metal or metal hydride support". The applicants understand this to be a 35 U.S.C. § 112 issue, since only the claims were amended and no new language was added to the specification. MPEP 608.04. Applicants believe it is thus properly viewed as a written description question or one of enablement.

The Federal Circuit in In re Kaslow (217 USPQ 1089 (1983)) and the CCPA in In re Wright (145 USPQ 182 (1965)) have held that a claim amendment need not find *in haec verba* support in the specification: "The test for determining compliance with the written description requirement is whether the disclosure of the application as originally filed reasonably conveys to the artisan that the inventor had possession at the time of the later claimed subject matter, rather than the presence

or absence of literal support in the specification for the claim language.” In re Kaslow, citing In re Edwards, 196 USPQ 465 (1978).

Here, the Office asserts that the term ‘metal’ used to describe the support for the EIPC coating of the invention lacks support in the specification. Applicants assert that one of ordinary skill upon reading the specification would understand that the support is a metal film, which becomes a metal hydride upon exposure to hydrogen. The specification at page 27, ll. 10-16 says, “Examples of supports include Pd, Pd alloys, and vanadium alloys.” The specification then states that “An example of a metal hydride foil is Pd. Other examples include alloys of Pd (e.g. PdAg alloys) and V/Ni/Ti, V/Ni, V/Ti...” One of ordinary skill would certainly know that Pd, Pd alloys, and vanadium alloys are metals. Hence metals are inherently disclosed as the support for the EIPC; making that explicit in the claims therefore adds no new matter. In re Wright, 145 USPQ 182 (CCPA 1965) (When reversing the rejection of added claims because they contained terms not identically present in the specification, the court said, “we hold that these concepts were inherently disclosed in the application as filed and the rejection of claims 15-28 on grounds of inadequate disclosure is reversed.”)

The preparation of the membranes of the invention is described as starting with a Pd foil to which the EIPC coating was applied (specification at 39). Use of a metal for the support is thus enabled. Finally, at page 23-24, the specification describes the operation of the device, where it lists materials for the support (Pd, PdAg, PdCu, Ti, LaNi₅, TiFe, and CrV₂—all metals) and states, “These materials reversibly absorb hydrogen.” (Pg 23, line 13). It also says, “protons can chemisorb as hydrogen onto the surface of the metal”. It also describes the face-centered cubic structure of Pd metal and how it is affected by hydrogen absorption, which “enables the use of Pd as

a support for the fabrication of composite systems capable of serving as membrane electrode assemblies for fuel cells.” This clearly describes a metal, Pd, as the support at issue.

The supports of the invention are thus interchangeably described as ‘metal’ or ‘metal hydride’ throughout the specification. The specification states that the absorption of hydrogen is reversible. And the specification identifies the material for the support as Pd, or one of a list of other metals and metal alloys, and provides an example using Pd foil as the support. One of ordinary skill reading this would understand that the support is a metal that becomes a metal hydride reversibly when exposed to hydrogen. Hence the specification fully conveys the claimed invention of a “metal or metal hydride support”, and the claim language used “simply made explicit a disclosure which was implicit in the application as filed.” Tektronix v. U.S., 170 U.S.P.Q. 100 (Ct. Cl. 1971). The term “metal or metal hydride support”, like its progeny in the later claims, is thus both described and enabled, so its use adds no new matter. Withdrawal of this objection is thus requested.

4. The trademark Nafion® does appear in the specification; it appears to be capitalized each time it is used. Sometimes it is used alone, but the first reference to it shows it as Nafion™, as do some of the succeeding occurrences. And in the added claims it was used only as “Nafion® 117”, which was properly used, capitalized and identified as a trademark. Thus applicants are confused about what the Office would have changed in regard to the form of its usage. The term has nevertheless been removed from the claims by the present amendment, and Applicants will amend the specification if that is required.

5. The Office objected to a number of parenthetical expressions in the amended claims. These have been removed or otherwise replaced in the presently amended claims.

35 U.S.C. § 112, Paragraph 1 Rejections

6.-7. The Office rejected the pending claims which contain a reference to a ‘metal support’ instead of or in addition to a “metal hydride support”, alleging that the specification fails to support the concept of a ‘metal’ support.

As described above, the specification provides extensive discussion of the fact that the support is a metal which reversibly absorbs hydrogen, when hydrogen is present, to become a metal hydride. It describes the preparation of a supported EIPC by adding a coating to a Pd foil, and identifies the material for the support as Pd or one of several alloys, each of which would be recognized as a metal by those of ordinary skill in the art. A metal support is thus clearly described by the specification as understood by those of skill, and that metal support is also clearly enabled by the description of preparing an example of the invention beginning with a Pd foil. Based on this and the cases and arguments presented above, applicants believe that this rejection is overcome and that cancellation of the term ‘metal’ as sought by the Office is unwarranted. Applicants respectfully request that this basis for rejection be withdrawn.

8. The Office correctly notes that the variables w, x, y, and z used to define one of the materials that can be used for the EIPC coating are missing from the specification and from claims 78 and 87. Applicants have thus deleted this material from the claims with the present amendment.

The Office also notes that the variable x is undefined in another listing of phosphoric acid salts listed in claims 78 and 87. These have also been deleted from the claims. The applicants note

that the symbol “D” in that list of materials [e.g., $\text{Cs}_{1-x}(\text{ND}_4)_x\text{D}_2\text{PO}_4$] represents deuterium (^2H), which would be recognized by those of skill in the art. Since the Office inquired about “D”, this explanation is offered for completeness, although the deletion of this group due to the missing variable renders this point moot with respect to the compounds challenged by the Office. The applicants note that CsDSO_4 also appears in those claims: the meaning of “D” in that expression is also ‘deuterium’, which would be clear to one of ordinary skill.

9. and 10. The applicants understand these two items to be explanations for item 8 (which notes the missing definition of variables in claims 78 and 87) and item 11 (noting use of trademark in claims 82 and 91). Responsive claim amendments are discussed in items 8 and 11, respectively.

11. The Office alleges that identification of the material Nafion® 117 by its trademarked name is indefinite in claims 82 and 91. The Applicants believe the trademark designates a specific material that is well known in the fuel cell literature, and would thus be completely descriptive of the material to one of ordinary skill at the time the application was filed based on the recurrence of that name in the references cited. Nevertheless, the claim limitation relying on that term has been replaced with a numerical limitation that is the measured equivalent of the limitation based on the named material; the determination of this value is set forth in the specification at page 45, ll. 15-17. The new limitation is thus supported by the original specification and adds no new matter.

12. The Office rejects claim 84 as indefinite because it incorporates by reference the contents of Figure 1. The applicants believe verbal expression of the matter would be excessively cumbersome and assert that the Figure best conveys the claim limitation. The Applicants have thus

incorporated Figure 1 into the claim. Since Figure 1 was presented with and described in the original application, it adds no new matter.

Art-Based Rejections

13.-14. The Office has rejected various claims as anticipated by or in the alternative rendered obvious by a number of references. The applicants note that the Office has offered only limited direct comparison of the elements of the claimed invention to the elements disclosed in the references; applicants will attempt to provide a detailed description of the differences to clarify how the present invention is distinguished from what the references describe.

One of the key differences is that the cited references having Pd or similar barriers in fuel cells invariably use it in combination with a polymer membrane such as Nafion® 117 or Nafion® 115. The Nafion® polymer membrane is ESSENTIAL to the functioning of these devices as EIPC's: it provides the electronic insulation ("EI" of an EIPC) that separates the anode from the cathode and thus prevents the fuel cell from 'short circuiting'. The polymer may also serve as one of the electrolytes, or another acid electrolyte may be present along with the membrane. But its electronic insulation function is essential: the combination could not function as an EIPC if that membrane did not provide electronic insulation as well as proton conductivity. Yet the Nafion® component prevents structures such as those in the cited references from operating in the desired temperature range, i.e. much above 100°C, because, "they have limited stability due to dehydration and desulfonation." T. Norby, *Solid State Ionics* 125, pg. 4 (1999).

The cited references provide objective evidence of nonobviousness.

Norby notes that, "no solid proton conductors working satisfactorily in the gap between, say, 200 and 500°C" are known. Norby, at 4. Norby discloses several solid proton conductor

compositions, but also recognizes that none work ‘satisfactorily’, apparently because no one had learned how to prepare a membrane of any of these materials having the necessary thickness and mechanical integrity to achieve a useful area specific resistance for proton conductivity. Applicants believe that this statement in Norby provides objective evidence that the present solution to the problem of providing proton conductors that are electronically insulating and operate in the desired temperature range was not obvious to those of ordinary skill: it clearly indicates that others have recognized this problem and have failed to solve it. See Graham v. John Deere, 383 U.S. 1 (1966) (‘failure of others’ is one factor that suggests that a claimed solution to a known problem is nonobviousness). Likewise, the statement in Norby that, “Narrowing this gap is of prime interest in the development of proton conductors for practical applications” (Norby at 4) is objective evidence of long-felt need for such fuel cells, which is also evidence of nonobviousness under Graham.

The cited references do not disclose or enable the claimed invention.

The present invention utilizes a metal or metal hydride film that supports a novel coating of an inorganic, non-liquid electrolyte. That coating serves both functions of the Nafion® polymer: it is electrically insulating, and it is proton-conducting. None of the references provides a functioning alternative to the Nafion® component in combination with a metal hydride or similar dense barrier. They may mention using other materials, but do not enable such materials in combination with a metal or metal hydride support, and a reference cannot anticipate without providing enablement. In re Hoeksema, 158 USPQ 596 (“to declare an applicant’s invention ‘not novel’ or ‘anticipated within section 102, the stated test is whether a reference contains an ‘enabling disclosure’....”). Nor can a reference render claimed subject matter obvious without enablement. See In re Lintner, 173 USPQ 560, 562 (CCPA 1972) (“In determining the propriety of the Patent Office case for

obviousness in the first instance, it is necessary to ascertain whether or not the reference teachings would appear to be sufficient for one of ordinary skill in the relevant art having the reference before him to make the proposed substitution, combination or other modification.”) While the metal or metal hydride support is an element of the present invention, the applicants thus draw the Office’s attention to the critical coating of an “inorganic or composite nonliquid” EIPC material, supported by a metal or metal hydride: none of the references discloses both of these elements.

No *prima facie* case for obviousness has been established.

The Office has also relied on an assertion that the claims, if not anticipated by the reference, are obvious in light of the references. The applicants will respond to each such rejection in turn, but point out that the Office in no instance has established a *prima facie* case for obviousness. The Office *at best* suggests some combinations that *could* be tried, but even if they were ‘obvious to try,’ that does not form the basis for a proper obviousness rejection. In re O’Farrell, 7 USPQ2d 1673 (Fed. Cir. 1988). A *prima facie* case for obviousness requires that the motivation to combine as well as a reasonable expectation of success must be explicit in the reference or found within the skill of an ordinary practitioner. “Both the suggestion and the reasonable expectation of success must be founded in the prior art, not in the applicant’s disclosure.” In re Vaeck, 20 USPQ 2d 1438 (Fed. Cir. 1991). The Office has pointed to no example where the cited references provide express motivation for making the combinations that are allegedly obvious. Nor has the Office provided any basis to represent that the combinations would be obvious to one of ordinary skill: the obviousness rejections seem to be largely based on impermissible hindsight analysis. *In re Dembiczak*, 50 USPQ2d 1614, 1617 (Fed. Cir. 1999) (“Our case law makes clear that the best defense against the subtle but powerful attraction of a hindsight-based obviousness analysis is

rigorous application of the requirement for a showing of the teaching or motivation to combine prior art references.”)

There is no motivation to combine the cited references.

An important question in this analysis is thus whether or not one would be motivated to combine the references. Here, the references such as Smotkin use a Pd or other metal or metal hydride in addition to a polymer membrane EIPC layer for one stated reason: it prevents diffusion of carbon dioxide or fuels such as methanol across the membrane assembly. See Smotkin , US 5,846,669 (Summary of the Invention, col. 2, ll.60-65 (emphasis added): “It is an object of this invention to provide an electrolyte system...which allows proton transfer through the electrolyte system *but prevents crossover of larger chemical species* from one electrode side to the other electrode side of the fuel cell.” See also col. 4, ll. 6-8: “the barrier...prevents carbonation from CO₂ produced at the anode.”). See also WO ‘777 (US equivalent 6,242,122, first line of the Abstract (emphasis added)): “An electrode-electrolyte unit for a fuel cell which *prevents the permeation of the fuel used or the permeation of water* through the electrolyte layer.” The combination of a Pd or similar barrier layer with a polymer EIPC in these references thus serves one purpose: the Pd layer solves the permeability problem known to arise with *polymer* EIPC materials.

When saying it would be obvious to combine references that teach other EIPC materials with the teachings of Smotkin or WO ‘777, the Office assumes, without explaining, that such barrier function would also be desirable in combination with these other EIPC materials. However, there is no evidence from the references that the other EIPC materials would require an additional barrier. The references disclosing other EIPC materials do not recognize any need for a support. And the other EIPC materials are not known to suffer from the carbon dioxide and/or solvent permeability

that polymer membrane EIPC materials like Nafion® suffer from. Since no permeability problem is shown to exist from the references provided, and no structural reason for using a support layer is disclosed, *there is no apparent reason even to try to combine Smotkin's Pd foil barrier with the other EIPC materials: there is no recognized problem to solve by making the combination.* The person of ordinary skill looking at Smotkin or looking at references disclosing new EIPC materials would use the other EIPC materials without a metal or metal hydride support. Only if one then encountered a permeability problem would one arguably be motivated to combine the references.

The present invention uses a metal or metal hydride layer, but NOT to solve a permeability problem: it uses a metal or metal hydride layer as a support for the EIPC, because the inventors found it enabled the EIPC to achieve the desired ASR while retaining mechanical integrity. The problem solved by the metal or metal hydride layer in the present invention is not even the same problem addressed by Smotkin and WO '777. Consequently, one would not be motivated to combine the teachings of any of the references disclosing inorganic or non-liquid composite EIPC materials with the teachings of Smotkin or WO '777.

There is no basis in the references to expect the claimed combination to succeed.

Since the references do not provide a reason to try the present combination, they cannot provide a 'reasonable expectation of success' in combining the elements. The combination of the references provide no reason to believe that an effective combination could be produced by using an EIPC material within the scope of the present claims and a metal or metal hydride barrier layer of Smotkin or WO '777. The cited references do not suggest that a supported layer of any inorganic or composite non-liquid EIPC material is desirable, nor *could* they suggest that a metal or metal hydride is the appropriate material to use for such support. None of the cited references provides a

way to make a coating of an EIPC material within the scope of the claims on a metal or metal hydride support because they do not recognize the desirability of doing so. They do not discuss how to interface an inorganic or composite non-liquid EIPC with a metal or metal hydride layer. The Office cites no reference showing or suggesting the preparation of any supported EIPC made of an inorganic or composite non-liquid material.

The Office has also overlooked the fact that the term “coating” itself indicates that the EIPC layer in the claimed component is not just adjacent to the metal or metal hydride: the support is “coated” with the EIPC material so that the two are interfaced well enough to provide proton conductivity through the multilayer composite. The Smotkin and WO ‘777 references that merely hot-press a polymer membrane against a Pd or similar film do not suggest that other materials can as easily be intimately interfaced to a Pd layer, nor do they suggest that materials that have very different physical, chemical and structural properties (e.g., the “inorganic or composite non-liquid materials”) can be successfully coated onto a metal or metal hydride layer.

The invention, by applying the EIPC material as a coating, provides proton conductivity across the interface. One of the references (WO ‘777) that describes a polymer layer with a palladium foil provides an additional layer of an unspecified ion-conducting polymer on the Pd or PdAg foil and then hot-presses the polymer membrane onto the treated foil, which “ensures that the ion-conducting polymer is intensively bound to the surface of the interlayer” (WO ‘777, col. 3 at 45-48). The problem of interfacing an EIPC material that is significantly different from a conventional flexible, liquid-containing polymer membranes (the references make it clear that the Nafion® membranes only work as proton conductors when hydrated) to a metal or metal hydride support is clearly different. No solution to this problem for other materials is provided by the cited

references, thus they do not enable construction of the presently claimed invention. This is an issue that the Office appears to overlook.

In short, the Office treats this as a mechanical device capable of predictable variations and combinations, when in fact it involves complex issues of material properties (e.g., carbon dioxide and/or solvent permeability, proton conductivity), structural integrity, and functional proton-conductive interfaces between dissimilar materials. Such oversimplifications are inconsistent with the cited references, which say that no operable solution to the problem of making EIPC's that operate in the 200 to 500°C temperature range (see Norby, pg. 4) is known.

The references do not enable construction of the claimed invention.

The references cited also fail to describe or enable the preparation of a structure that falls within the scope of the present claims. The present invention requires preparation of a coating of a proton conducting material (EIPC) on a metal or metal hydride surface. The metal or metal hydride surface is flexible and may be subject to expansion as hydrogen is absorbed. See the specification at pg. 24. The cited references provide no guidance on the preparation or properties of coatings of such EIPC materials on any support. Furthermore, the references offer no evidence that EIPC materials could be successfully interfaced to a metal or metal hydride film like the ones used here to support the EIPC coating. The references describe hot-pressing Nafion® polymers onto metal foils; however, there is no indication that other EIPC materials could be coated onto a metal layer by similar methods. Thus one of ordinary skill would not have been able to make the structures claimed based on any combination of the cited references without undue experimentation.

15. The Office rejects claims 75-77, 82, 84-86, and 91 over Smotkin, US Patent No. 5,846,669 (Smotkin), alleging that Smotkin renders the claims either anticipated or obvious.

A showing of anticipation requires that the reference disclose and enable every element of the claimed invention. According to the Office, Smotkin “discloses” electrolytes for fuel cells “operating in a temperature range up to about 300°C.” But the statement in the reference is merely an assertion of intended benefit in the ‘Background of the Invention’ section, not an enabled or described device: the Supreme Court long ago held that a reference cannot anticipate that which it does not enable. Seymour v. Osborne, 78 U.S. (11 Wall.) 516 (1870).

Smotkin teaches the use of a ‘dense phase’ that is proton-permeable as a means to separate acid and base electrolytes in a fuel cell, and employs a Pd foil for such barrier. However, it provides little discussion of the fact that because Pd is electrically conducting it must be accompanied by a layer that is electrically insulating (the “EI” of the EIPC required for a functional fuel cell using a membrane separated configuration). The Example in Smotkin provides a layer of Nafion® 115 polymer to perform that “EI” function, and Smotkin’s only disclosure of alternative materials that arguably could serve this purpose mentions “concentrated phosphoric acid in a silicon carbide matrix” or “concentrated potassium hydroxide in a potassium hexatitanate matrix”. None of these materials falls within the scope of the present claims which require a ‘non-liquid material’. Smotkin discloses only the use of a polymer membrane (which necessarily contains a liquid phase: the references state that the Nafion® membranes only operate at temperatures where they are hydrated—see Norby) in contact with a Pd foil or the *possibility* of using other liquid-containing matrices (“concentrated potassium hydroxide” or “concentrated H₃PO₄”, each of which is well known to those of ordinary skill to be a liquid) in place of the hydrated polymer. Nor does the disclosed operation of the Smotkin device with aqueous sulfuric acid on one side of the assembly and aqueous KOH on the other side anticipate, since both of these electrolyte solutions are liquids.

Thus Smotkin does not describe or enable a metal or metal hydride support with an EIPC coating that is an inorganic or composite non-liquid material.

Furthermore, neither the polymer layer nor the ‘liquid in a matrix’ would constitute a ‘coating’ as that term is normally understood or as it is used in the specification. Nor does the concurrent presence of a second material adjacent to a metal foil render that material ‘supported’ by the metal or metal hydride “support” as that term is ordinarily used and understood. Thus Smotkin does not anticipate the claimed invention.

First Examiner’s Note: the Office alleges that “an inorganic or non-liquid composite” as used in the claims “covers a very large number of applicable materials.” The Office cites MPEP 2112 and asserts that the ASR, as an inherent characteristic, fails to distinguish the present invention from the prior art because it reads on “any inorganic or composite non-liquid material.” The Office asserts that novelty is thus lacking in the present claims.

The Office’s assertion of a lack of novelty appears to rely on the assertions that the materials of the EIPC of the invention are indistinguishable from those mentioned in Smotkin other than by inherent physical properties. Yet they have been distinguished as described above, since Smotkin does not disclose any non-liquid containing EIPC materials. The Office cites cases that relate to claim limitations based only on functional properties (the rate of cooling in In re Best, 195 USPQ 430, 432) or inherent physical characteristics (the intrinsic shrinkage properties of a ‘product by process’ in In re Fitzgerald, 205 USPQ 594, 597), but the presently claimed invention is distinguished by explicit structural limitations (the use of inorganic or composite non-liquid EIPC materials to form a coating that is supported by a metal or metal hydride layer) from the devices in

the references. Since the product itself is clearly distinguishable from those of the references, the applicants believe this ground for rejection is overcome.

The Office suggests that the EIPC's claimed use "at least similar compositions" to those of the prior art in combination with the metal or metal hydride layer of the prior art. Respectfully, the applicants note that the claimed coating is expressly described as an "electronically-insulating proton-conducting" (EIPC) material: that language substantially limits the materials that fall within the scope of the claim, because there are only a small number of materials known to possess proton-conductivity. The scope is further limited by the phrase, "of an inorganic or composite non-liquid material." This limitation defines a class of materials by composition (inorganic or composite) rather than function, and it excludes the known, conventional hydrated polymer layers like Nafion® membranes and other liquid-containing matrices like those mentioned above. As described above, none of the compositions described in Smotkin fits the structural limitations to anticipate the claimed device: each material Smotkin describes that would be in contact with the Pd layer contains a liquid phase. The ASR limitation is included to limit the thickness of the coating: while any specific coating that is an EIPC would indeed have an inherent "area specific resistance for protons", as the Office notes, that ASR depends on the thickness and the identity of the material as well as the operating temperature. Thus the ASR limitation includes a functional value, but it uses that value to impose an additional structural limitation on the claimed component, not to distinguish the claimed component from the prior art.

Also, the Office seems to ignore the rest of the claim: the claimed component is a combination of elements. It includes a support of a metal or metal hydride and a coating defined by composition and thickness limitations. Rejection of the claim merely because an element is partly

defined by function is improper as long as the claim is definite and supported by the specification. See, e.g., In re Swinehart, 169 USPQ 226 (CCPA 1971)(Approving use of the claim term ‘transparent’, and saying that functional language may present questions of definiteness, adequacy of disclosure, or overbreadth, but is otherwise unobjectionable.)

The applicants have chosen to claim the invention to include only those EIPC coatings that fall within a potentially useful range for the intended applications, but the claim limitations do NOT rely on the inherent ASR property to distinguish them from the prior art: they are entirely distinguished by structural limitations. The range of ‘coatings’ which fall within the scope of the claim is limited, and the materials are claimed only as a coating on a metal or metal hydride support. The Office’s contention that any inorganic or composite non-liquid material in contact with a Pd layer inherently anticipates the invention, and that the claims rely only on disclosure of an inherent property (ASR) for novelty, is thus not supported.

Second Examiner’s Note: The Office asserts that the preamble does not limit the scope of the claims. The present invention is structurally distinguished from those described in the cited references without reliance upon the preamble as a limitation as just described. The applicants thus believe that the structural limitations of the claim render the claimed invention both novel and nonobvious.

As explained above, the invention uses EIPC materials that are not disclosed in Smotkin and are structurally distinguished from those of Smotkin. This is not a situation where the claims are distinguished over prior art only by disclosure of an inherent property: the claims provide a novel structure, a coating of an inorganic or composite non-liquid EIPC on a metal or metal hydride support. Smotkin does not disclose any EIPC that falls within the claim scope, nor a ‘coating’ of

such material on a metal or metal hydride support. Thus the Office has not established that Smotkin anticipates the claimed invention.

Furthermore, the applicants reiterate the above comments which show that the Office has not established a *prima facie* case of obviousness. Smotkin teaches use of a metal barrier to solve a permeability problem; it does not provide motivation to combine a metal barrier layer with other EIPC materials that are not known to suffer from permeability problems. Nor does Smotkin enable preparation of a coating of such other EIPC materials on a metal or metal hydride support. Smotkin does not recognize or solve the problem of interfacing any non-polymer EIPC material onto the metal barrier layer the way Smotkin's Nafion® membrane is interfaced to its metal foil. Smotkin does not provide either motivation to combine or a reasonable expectation of success.

The Office referred to the claimed invention as a 'similar product' to membrane assemblies in Smotkin, despite the fact that the materials presently used are substantially different, as shown above. Moreover, the cases cited in support of the obviousness rejection over Smotkin (In re Best; In re Fitzgerald) are cases where the claimed invention was distinguished from the prior art only by an inherent property or characteristic. Here, there are structural differences that clearly distinguish the claimed invention from the cited references: unlike the polymer layers in Smotkin, the EIPC layer in the present invention does not contain a liquid phase; furthermore, it is an inorganic or composite coating on a metal support layer rather than a polymer layer that is simply hot-pressed to a metal foil. The Office also has ignored objective evidence of nonobviousness in the references showing that those skilled in the art did not know of any structure that would achieve the properties disclosed for the present invention despite a motivation to find such structures. See Norby pg. 4.

Thus the Office's rejection for obviousness over Smotkin is believed to be overcome, and the applicants request that this ground for rejection be withdrawn.

16. The Office asserts that claims 75-77, 80-82, 84-86 and 89-91 are anticipated or obvious in light of the WO 98/21777 patent (WO '777). The applicants have relied on the US counterpart, US Patent No. 6,242,122 ('122) in preparing this response, but will refer to it as the WO '777 reference for consistency with the office action. The '122 patent and WO '777 are both based on PCT Application DE97/02551 and both include the same figures.

The Office appears to rely heavily on the diagram that shows two electrolyte layers on either side of a palladium-silver alloy foil, and the reasoning used in relation to the Smotkin reference. Indeed, WO '777 addresses the same problem as Smotkin: at col. 2, ll. 4-5 in the U.S. counterpart ('122), it says that the object of the invention is an electrode-electrolyte unit "in which the permeation of the fuel used or the permeation of water through the electrolyte layer is prevented." The same rebuttal arguments apply here: the reference only describes its device in terms of a polymer membrane. The conventional polymer membranes are known in the art to permit carbon dioxide and/or solvent molecules to diffuse through, degrading their performance. Like Smotkin, WO '777 essentially provides a conventional polymer membrane, and adds a metal or metal hydride layer as an additional barrier to prevent gases or solvent molecules from diffusing through the polymer membrane. For example., in the '122 English language version at col. 3, ll. 18-30, the reference describes "an adjoining electrolyte layer consisting of a **polymer** membrane 4, methanol and water being additionally entrained at the same time...", and says "barrier layer 5 is followed by a **conventional polymer membrane 6...**" The PdAg foil preparation describes deposition of a microporous PdAg layer onto the foil, which is then "coated on both sides with an ionconducting

polymer” onto which a polymer membrane is then hot-pressed. Thus if a “coating” is taught in WO ‘777, it is either the “ionconducting polymer” or it is the hydrated Nafion® membrane, neither of which falls within the present claims. WO’777 thus fails to anticipate the present claims, because it neither describes the materials of nor enables the preparation of the claimed invention.

As described above, it would also not be obvious to one of ordinary skill that the polymer could be replaced with the “inorganic or composite non-liquid material” of the coatings of the present invention, or how to achieve such replacement. Nor would it be obvious that using the barrier of WO’777 is desirable with the other EIPC materials, since they are not known to have a permeability problem that might motivate one to use a barrier layer in combination with their EIPC material. Norby strongly suggests that those familiar with the “conventional” polymer membranes knew of no alternative that would work at higher temperatures (well above 100°C) like the EIPC’s of the present invention do.

Furthermore, the applicants reiterate the above comments which show that the Office has not established a *prima facie* case of obviousness. WO ‘777 teaches use of a metal barrier to solve a permeability problem, just as Smotkin does; it does not provide motivation to combine a metal barrier layer with other EIPC materials that are *not known to suffer from permeability problems*. It does not disclose or suggest that other EIPC materials may require a supporting layer, or suggest using a metal or metal hydride for the support. Nor does WO ‘777 enable preparation of a coating of such other EIPC materials on a metal or metal hydride support: like Smotkin, it describes mounting a free-standing polymer membrane on a metal foil layer by hot-pressing the two together. But WO ‘777 does not describe any way to ‘hot press’ or otherwise interface or “coat” a non-polymer EIPC material onto the metal barrier layer the way a Nafion® membrane is interfaced to a

metal foil, and the Office has provided no basis to assert that making such an intimate interface between a metal or metal hydride layer and an inorganic or composite non-liquid EIPC material of the present claims is within the knowledge of one of ordinary skill.

As discussed above for Smotkin, the Office has not established that the claimed invention is sufficiently 'similar' to the WO '777 membrane assemblies to justify the assertion that they are distinguishable only by disclosure of inherent properties. Indeed, the assemblies in WO '777 and Smotkin are similar to each other, so the arguments for distinguishing them are similar. The Office also has ignored objective evidence of nonobviousness in the references showing that those skilled in the art did not know of any structure that would achieve the properties disclosed for the present invention despite a recognized motivation to find such structures. See Norby pg. 4. The Office discusses the thickness of the metal layer of the component in WO '777 and that in the present invention, and concludes that the ranges may overlap; nevertheless, since the nature of the EIPC coating on the metal layer is clearly distinguished by structure from that of WO '777, the reference cannot anticipate or render obvious the present claims based only on the similarity in the thickness of the metal layer. Thus the Office's rejection for obviousness over WO '777 is believed to be overcome, and the applicants request that this rejection be withdrawn.

17. The Office asserts that claims 75-77, 80-82, 84-86, and 89-91 are anticipated or obvious in light of Saito, which is a published patent application, US 2002/0034672.

First, Saito is arguably non-analogous art: the separator of Saito is a completely different component—though it is part of a fuel cell, and admittedly its function is not made completely clear by Saito. The component in Saito is not an EIPC and does not separate the anode and cathode sides of a fuel cell, it apparently separates one fuel cell from the next. It is designed to allow gas flow to

proceed unimpeded by water that is produced when the fuel cell operates, and “has at the same time low electrical resistance.” (Saito Abstract). Low electrical resistance means that the component is an electrical conductor, thus it cannot be an EIPC without the electronically insulating (“EI”) property. The coating on the separator of Saito is expressly described as conductive. See ¶0020: “applying a conductive coating...to form, on the base material, a film made of the conductive coating...” (emphasis added). A “conductive coating” cannot be equated to the EIPC coating of the invention, which is expressly electronically NON-conducting. An EIPC ONLY conducts protons, not electrons. Thus the device in Saito does not anticipate: Saito does not disclose an EIPC in structure or function, and the electrical resistance which the Office computes is irrelevant because it refers to “electrical” resistance rather than ASR “for protons” that is explicit in the present claims.

Furthermore, the applicants reiterate their comments above: the Office has not established a *prima facie* case of obviousness, which requires the Office to show where motivation to combine references is found as well as a reasonable expectation of success in making the combination. Since the reference discloses only “conducting” coatings on a metal component, one would not be motivated to use its teachings in the preparation of an EIPC structure such as that presently claimed. The reference does not teach anything about an ‘electronically insulating’ layer OR a ‘proton conducting’ one, thus the Office’s assertion of obviousness is overcome, and the applicants request that this rejection be withdrawn.

18-19. The Office asserts that claims 78-79 and 87-88 of the present invention are obvious based on Smotkin in combination with Norby (Solid State Ionics 125, 1-11 (1999)). For the record, Norby is self-described as “a brief overview” (abstract).

The Office says that Norby teaches “a hydrogen permeable membrane” (ABSTRACT), but the rest of that sentence says “in hydrogen separation technologies.” This use thus is not related to an EIPC structure, as it merely recites a well-known utility of membranes such as Pd and its alloys that does NOT involve or require an EIPC coating. The applicants do not understand, therefore, what is meant by the Office’s reference to the phrase. Norby also discloses, as the Office states, that proton conductive materials are candidates for electrolytes in fuel cells; but that is merely a very general background comment on something familiar to those of ordinary skill in the art. Norby also does mention “proton exchange membranes” (PEM) as the Office states: it defines this as “a commonly used term for **polymer-based** proton conductors.” See Sect. 4.1. Thus the term PEM is totally irrelevant to the present claims, which provide an alternative to the conventional polymer membranes: the conventional polymer membranes require a liquid phase (hydration) to function as EIPC’s, while the claimed invention includes only non-liquid EIPC materials. The applicants are thus confused by the Office’s references to these terms.

The Office then notes that Norby mentions that $\text{Ba}_3\text{Ca}_{1.18}\text{Nb}_{1.82}\text{O}_{8.73}$ (BCN18) is a proton conductor, and apparently intended to point out that CsHSO_4 and certain Sr and Ba salts are also discussed as such. The Office mentions hydrogen permeable membranes, then notes that “such specific proton conductor material enhances the transport of protons for both chemical processes and chemical conversion process (Section: 3. Properties).” The applicants interpret this as an assertion by the Examiner that one of ordinary skill would be motivated to add an EIPC as a proton conductor layer to a Pd layer used for hydrogen separation, hence producing a structure that would anticipate the claimed device. But the EIPC proton conductors are actually rate-limiting with regard to proton conductivity when added to a metal or metal hydride, as demonstrated and discussed in the

specification at page 30. They do not enhance proton conductivity of the metal or metal hydride support as the Office appears to suggest. Indeed they slow it down, which is why the EIPC coating in the example was made progressively thinner until its proton conducting performance matched that of the conventional Nafion® membrane systems. There would thus be no motivation to apply these EIPC coatings to enhance hydrogen transport (*i.e.*, as hydrogen permeable membranes), if that is indeed what the Office is referring to with the comments provided at 19. Furthermore, since the present application relates to fuel cell construction, references to hydrogen permeable membranes, even if used in conjunction with a fuel cell, are arguably non-analogous art.

If the Office intends only to assert that Norby renders it obvious to use the other listed EIPC materials in place of the polymer membrane of Smotkin, the applicants reiterate their comments above: the Office has not established a *prima facie* case of obviousness. The preceding paragraph rebuts any implication that one would be motivated to add an EIPC layer to a palladium membrane to enhance hydrogen separation: the EIPC layer slows down proton conductivity rather than enhancing it. The comments above have also shown that one who recognized that the metal layers in Smotkin and in WO '777 were used to solve a known permeability problem with Nafion® membranes would not be motivated to combine such metal layers with other EIPC materials for which no permeability problem was known to exist. Nor does Norby suggest any reason for combining an inorganic or composite non-liquid EIPC material with a metal layer, or recognize the problems of interfacing the two, which is solved in the present invention by coating the metal or metal hydride with the EIPC material. Norby, indeed, teaches that EIPC membrane components that operate in the 200 to 500°C temperature range, as this one does, were both desirable and

unknown in 1999, providing objective evidence of nonobviousness. Thus the Office's assertion of obviousness is overcome, and the applicants request that this rejection be withdrawn.

20. The Office rejects claims 78-79 and 87-88 as obvious in view of Smotkin in combination with Crome, US Patent No. 5,985,113. The applicants note that Crome is really non-analogous art: it is related to methods of injection-molding to make a ceramic apparatus that may be used as a chemical reactor or fuel cell. It does mention some of the same materials included in the specification and claims of the present application; however, it does not provide any information about their proton conductivity. The mere fact that they are disclosed as 'electrolytes' does not provide motivation to view them as EIPC materials: while EIPC's are electrolytes, not all electrolytes are EIPC's. With NO information about the properties of the materials other than their asserted utility in the apparatus and methods of Crome, one of ordinary skill would not be motivated to look to Crome in search of elements to combine with Smotkin. Nor does Crome lead one to recognize a need for such combination.

The Office asserts that Crome at least teaches the substitution of Sc for other metals that are known as proton conductors from other references, and asserts that 'those of ordinary skill in the art knows [sic] that scandium (Sc) element may be a substitute element in composite materials as both elements Sc and Ga shows [sic] the same chemical valence.' Applicants note that Norby demonstrates the fallacy of this oversimplification: it teaches that LaGaO_3 is NOT a proton conductor even though both LaScO_3 and LaErO_3 are. Thus the mere fact that two elements are 'equi-valent' does not necessarily make them 'equivalent'. Where complex material properties like proton conductivity are concerned, elements are NOT interchangeable just because they show "the same chemical valence," as was asserted in the Office action.

Also, the Office points out Sc as a material that “can be selected from a variety of groups and mixtures” in the reference. But this does not render obvious any particular composition in the absence of teachings in the reference guiding one toward the particular compound. *In re Jones*, 21 USPQ2d 1941 (Fed. Cir. 1992) (Allowing a claim to a specific compound in a later application even though the compound fell within an earlier disclosed broad genus, the Court said, “Conspicuously missing from this record is any evidence, other than the PTO's speculation (if it be called evidence) that one of ordinary skill in the herbicidal art would have been motivated to make the modifications of the prior art salts necessary to arrive at the claimed 2-(2'-aminoethoxy)ethanol salt.”) Thus the fact that Sc is among the “variety of groups and mixtures” enumerated in the reference does not render it “obvious” in the absence of guidance that would lead one to select that particular tree from among the forest of alternatives “and mixtures thereof” disclosed by the cited reference.

Furthermore, the applicants reiterate the comment that the Office has not established a *prima facie* case for obviousness, and has ignored objective evidence in the references (see Norby, pg 4) of nonobviousness. Crome does not even discuss proton conductivity; it is unclear why one would use it as a source of guidance in selecting materials for an EIPC. Crome thus provides neither motivation to combine nor a reasonable expectation for success in making the combination, and it does not enable one to make the claimed components. As previously discussed, Smotkin does not provide motivation to combine with other references, either, in the absence of a permeability problem such as the one that the metal barrier layer in Smotkin was used to solve. Neither Crome nor Smotkin discloses such a permeability problem with other EIPC materials. Thus the Office's

rejection for obviousness over Crome in view of Smotkin is overcome, and the applicants request that this rejection be withdrawn.

21. The Office asserts that claims 78-79 and 87-88 would have been obvious over Smotkin in view of Kwang (Solid State Ionics 125, 355-67(1999)).

The compositions in Kwang do exhibit at least some proton conductivity; however, their properties are not well explored. The last two sentences in the paper say:

“From these investigations, the compound $\text{BaCe}_{0.7}\text{Zr}_{0.2}\text{Nd}_{0.1}\text{O}_3$, which is stable in CO_2 for at least the short periods examined, appears most suitable for fuel cell applications. The composition $\text{BaCe}_{0.5}\text{Zr}_{0.4}\text{Gd}_{0.1}\text{O}_3$ is also stable, and its electrical properties are under investigation.” This indicates that Kwang is an investigation in progress, and suggests that the compositions described were *at best* the basis for experiments that might optimistically be “obvious to try”. The reference describes preparation of a sample of one of the doped compounds that required high pressure and temperature to obtain high density (Kwang, pg. 363); this method of preparation appears inconsistent with forming a coating on a metal or metal hydride support, especially when the interface between the two layers must be proton-conductive and non-electronically conductive. In fact, the reference tells very little about fabricating components from the proton conductors discussed, thus it is impossible to tell whether coatings can be produced, on what surfaces they might advantageously be formed, or what properties they might possess. Kwang thus does not enable one of ordinary skill to make the claimed components, which consist of a coating of an EIPC on a metal or metal hydride support.

Furthermore, the applicants reiterate their comment above: the Office has not established a *prima facie* case of obviousness. The Office has not established why one would be motivated to

combine the references. Smotkin provides motivation to add a metal layer to an EIPC layer as a permeability barrier, but only if the EIPC itself is known to be permeable to carbon dioxide and/or solvents. Kwang does not disclose any permeability problem with the disclosed materials. Nor does Kwang teach that the EIPC materials it discloses need a support: its reference to the stability of the proton-conductive compositions is expressly to “chemical stability” (Kwang at 367) rather than any need for mechanical support. Thus one of ordinary skill might attempt to use the compositions of Kwang for fuel cell applications, but would not be motivated to combine them with a metal or metal hydride barrier. The Office has also ignored objective evidence in the references that the present invention was in fact NOT obvious to those of ordinary skill at the time it was made despite a motivation to produce it (see Norby, pg. 4), and has ignored the lack of enablement for preparation of structures that fall within the scope of the present claims. Thus the Office’s assertion of obviousness over Kwang in light of Smotkin is overcome, and the applicants request that this ground for rejection be withdrawn.

22. Claims 78-79 and 87-88 stand rejected as obvious over Smotkin in view of Lybye (Solid State Ionics 125, 339-344 (1999)). The Office notes that the reference “suggests” that a certain composition is a proton conductor.

Lybye discusses $\text{La}_{0.9}\text{Sr}_{0.1}\text{Sc}_{0.9}\text{Mg}_{0.1}\text{O}_3$, and presents results which “suggest that $\text{La}_{0.9}\text{Sr}_{0.1}\text{Sc}_{0.9}\text{Mg}_{0.1}\text{O}_3$ is not only an oxide ion conductor but also a proton conductor.” (Sect. 3). Notably, the reference teaches that this material was also found to have substantial p-type conductivity, described in the Table 1 caption as “**p-type electronic conductivity.**” This material is thus at best a mixed conductor, and its p-type electronic conductivity would limit its utility as a proton conductor for an EIPC coating, since “EI” means electronically insulating. Thus one of

ordinary skill would not be motivated to choose this material for making an EIPC in light of its recognized p-type electronic conductivity, and would not have a reasonable expectation of success with it.

In addition, even in the Office's own quotation the reference only "suggests" that a particular composition has desirable properties; that hardly provides the basis to render combinations using that composition 'obvious'. It appears *at best* to be 'obvious to try' such combinations: the statement from the reference would not give one a "reasonable expectation of success." This alone establishes that the obviousness rejection is improper. And the conclusion by the authors of the reference even says, " $\text{La}_{0.9}\text{Sr}_{0.1}\text{Sc}_{0.9}\text{Mg}_{0.1}\text{O}_3$ is a mixed conductor exhibiting p-type conduction at high oxygen partial pressures and ionic conduction at low oxygen partial pressures." Applicants believe this clearly undermines the Office's implication that it would be 'obvious' to use this material for making an EIPC coating supported on a metal or metal hydride, since it would not be expected to function as an EIPC under 'normal' conditions of high oxygen partial pressure.

Furthermore, the applicants again note that the Office has not established a *prima facie* case of obviousness. There is no motivation to combine the permeability barriers of Smotkin with other EIPC materials from Lybye that are not known to have permeability issues. There is no enablement in Lybye for fabrication of the claimed invention, because it provides no reason to and no way to interface an inorganic or composite non-liquid EIPC material with a metal or metal hydride support. The Office has ignored objective evidence of nonobviousness in Norby (pg. 4) and the absence of enablement for making coatings of the EIPC materials that fall within the scope of the claims. Thus

the Office's assertion of obviousness over Lybye in combination with Smotkin is overcome, and the applicants request that this rejection be withdrawn.

Summary

The Office has not shown that the claimed component is identical to any known device: no reference was cited that discloses a coating of an electronically-insulating proton-conducting (EIPC) material that is an inorganic or composite non-liquid on a metal or metal hydride support. Since the structure is novel, the functional limitation on the thickness of the EIPC coating (requiring its area specific resistance to fall within stated limits) need not be relied upon to avoid inherent anticipation.

Furthermore, the Office has not established a *prima facie* case of obviousness. No motivation has been shown for combining the permeability barriers of Smotkin or WO '777 with any of the disclosed EIPC materials that fall within the scope of the claims, because none of the references indicate that the other EIPC materials have permeability problems. Nor do they suggest any need for a support for mechanical stability. The references simply fail to suggest a problem that would be solved by combining the permeability barrier of Smotkin or WO '777 with other EIPC materials. Thus one of ordinary skill would not be motivated to combine Smotkin or WO '777 with any cited reference disclosing other EIPC materials. Nor does any reference teach or enable a method to apply a coating of an inorganic or composite non-liquid EIPC to a metal or metal hydride support. Furthermore, there is objective evidence of nonobviousness in Norby, which shows that those of skill in the art were motivated to make components like those of the present invention, but did not know of components with the properties required. The applicants thus believe that both novelty and non-obviousness have been established relative to each of the cited references.

Request for Comments

Applicants have attempted to claim certain aspects and embodiments of their invention specifically and succinctly. Yet the applicants are aware that nuances in claim wording often give rise to objections. Should the Office believe that the claim wording could be improved or altered in some minor way to expedite prosecution, a telephone call to the undersigned is respectfully requested.

CONCLUSION


The claims have been amended to address previous comments from the Examiner. The applicants believe that each of the formal objections has been addressed, and that the above comments clearly highlight how the present invention is patentable over each of the cited references. The claims should now be in condition for allowance, and reconsideration is requested.

In the unlikely event that the transmittal letter is separated from this document and the Patent Office determines that an extension and/or other relief is required, applicant petitions for any required relief including extensions of time and authorize the Assistant Commissioner to charge the cost of such petitions and/or other fees due in connection with the filing of this document to **Deposit Account No. 03-1952** referencing docket No. **491712000100**.

Respectfully submitted,

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